out of date. No notice is taken of the labours of Callender, Savory, Bristowe, or Braidwood, to say nothing of Cohnheim, whose views, if accepted, are, we need hardly say, likely to completely revolutionize our ideas as to the possibility of pus entering the circulation.

Looking upon this volume as a whole, we cannot avoid a certain feeling of disappointment. The papers which Dr. Lidell contributed in former years to this Journal were so very good, that our expectations were possibly thereby raised to an unreasonable pitch; and we are sorry to find the contents of this book neither so new nor so exhaustive of the subjects discussed as we had anticipated. We are particularly sorry for this, because the book, from its semi-official character, as published by the Sanitary Commission, will excite more attention abroad than if it were merely issued upon the responsibility of an individual. More than this, the whole book comes, to use an old expression, as it were, "the day after the fair;" the "War of the Rebellion" is over; its lessons have been taught, and, we think, pretty well learned by those who are not past learning anything at all; and though the Horatian nine years of probation may improve the quality of poetry, any researches in so progressive a science as that of surgery must lose their freshness, if even three years elapse between the writing and the reading. The bringing to light of posthumous scientific works is always of questionable expediency; but particularly so when it is not the author, but the doctrines he inculcates, that are dead before the day of publication. J. A., Jr.

ART. XX.—*The Physiology of Man; designed to represent the Existing State of Physiological Science, as applied to the Functions of the Human Body.* By AUSTIN FLINT, Jr., M. D., Professor of Physiology and Microscopy in the Bellevue Hospital Medical College, New York; Fellow of the New York Academy of Medicine; Member of the Medical Society of the County of New York; Resident Member of the Lyceum of Natural History in the City of New York, &c. &c. *Secretion, Excretion, Ductless Glands, Nutrition, Animal Heat, Movements, Voice and Speech.* 8vo. pp. 526. New York: D. Appleton & Co., 1870.

OUR readers will remember that we have already presented them with brief reviews of the first two volumes of this work. These volumes treated of the blood, circulation, respiration, alimentation, digestion, absorption, and the lymph and chyle. The volume now before us is devoted to the consideration of secretion, nutrition, calorification, ciliary, elastic and muscular movements, and to the voice and speech. In the preparation of "The Physiology of Man," Prof. Flint has endeavoured to make each volume a separate and distinct treatise, complete in itself, the full series being intended to cover the entire subject of physiology.

The first chapter of the volume just published treats of secretion in general, the relation of this function to nutrition, the mechanism of its production and of that of the excretions, and the extent to which it is influenced by the composition and pressure of the blood and by the nervous system. The structure of the various secreting organs is also described.

The second chapter is occupied with an account of the physiological anatomy of the serous, synovial, and mucous membranes, and of the sebaceous, ceruminous, and Meibomian glands. The physical characters, chemical composition, and uses of the different serous, synovial, mucous, and sebaceous fluids are carefully described.

The whole of the third chapter is taken up with the consideration of the mammary secretion. Prof. Flint, in his anatomical description of the mammary glands, adopts the conclusions of Robin, as to the physiological changes which these organs undergo during the different periods and conditions of female life.

According to Robin and Sappey, the mammary gland, during the intervals of lactation, is not a secreting organ.

> "It presents the ducts ramifying to a certain extent in the substance of the lobes into which the structure is divided, but their branches are short, and possess but few of the glandular acini that are observed in every part of the organ during lactation. This difference in the structure of the gland is most remarkable, and as it passes from a secreting to a non-secreting condition at the end of lactation, the ducts retract in all their branches, and most of the secreting *culs-de-sac* disappear. At this time the glandular tissue is of a bluish-white colour, and loses the granular appearance which it presents during activity. The ducts are then lined with a small nucleated pavement-epithelium, which is not found during the secretion of milk. These changes, pointed out by Robin, whose observations have been verified and extended by Sappey, are confined almost exclusively to the secreting structure of the glands. The interstitial tissue remains about the same, the bloodvessels, only, being increased in number during lactation. * * *
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> "Each acinus of the mammary gland is made up of from twenty to forty secreting vesicles or *culs-de-sac*. These vesicles are irregular in form, often varicose, and sometimes enlarged and imperfectly bifurcated at their terminal extremities. During lactation their diameter is from $\frac{1}{400}$ to $\frac{1}{300}$ of an inch. During pregnancy, and when the gland has just arrived at its full development, the secreting vesicles are formed of a structureless membrane, lined with small nucleated cells of pavement-epithelium. The nuclei are relatively large, ovoid, and imbedded in a small amount of amorphous matter, and they almost touch each other. Sometimes the epithelium is segmented, and sometimes it exists in the form of a continuous nucleated sheet. When the secretion of milk becomes active, the epithelium entirely disappears, and reappears as the secretion diminishes. This observation is due to Robin, and has an important bearing upon the mechanism of the secretion of milk.
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> "During the intervals of lactation, as the lactiferous ducts become retracted, the grandular *culs-de-sac* disappear; and in pregnancy, as the gland takes on its full development, the ducts branch and extend themselves, and the vesicles are gradually developed around their terminal extremities. These changes in the development of the mammæ at different periods are most remarkable, and are not observed in any other part of the glandular system."

From this description it will be seen that the mammary glands differ from other glandular organs in the fact that while in the latter epithelial cells seem to be the active agents in producing the secretions, in the mammæ the disappearance of the epithelium from the secreting *culs-de-sac* during the period of greatest functional activity of the gland leaves the work of secretion to be performed by the amorphous membrane of the vesicles alone.

A large portion of the third chapter is occupied with an account of the mechanism of the secretion of milk, the conditions which influence this secretion, such as diet, mental emotion, &c., the quantity, properties, composition, and microscopical characters of milk, &c.

The next four chapters are devoted to the excretory action of the skin and kidneys. The differences between the secretions proper and excretions, and the composition, mode of production and discharge of the excretions are briefly discussed. The physiological anatomy of the skin and kidneys is described with sufficient minuteness of detail. Prof. Flint dwells at some length, also, upon the mechanism of the formation and discharge of the urine, fully recognizing the important relations which this act bears to the processes of nutrition and disassimilation, and the necessity of studying all the conditions by which it may be modified.

In 1821 Prévost and Dumas detected, for the first time, urea in normal blood. Their observations were confirmed and extended by Ségalas and Vauquelin in 1822, and verified in the human subject, in a case detailed by Shearman in 1848. Subsequently Marchand, Picard, Poisseuille, Gobley, and others, have shown that urea is a normal constituent of blood. Still more recently, Wurtz has proven that this substance is ordinarily present in the lymph and chyle in larger quantities than in the blood.

> "These facts, which have been almost universally regarded as established, have led physiologists to adopt the view that the peculiar excrementitious principles found in the urine are not produced by the kidneys, but are formed in the system by the general process of disassimilation, are taken up from the tissues by the blood, either directly or through the lymph, and are merely separated from the blood in the kidneys; and it has consequently been pretty generally assumed that nearly, if not all, the constituents of the urine preëxist in the circulating fluid. There is, indeed, no well-defined principle in the urine that has not been actually demonstrated in the blood. As an additional argument in favour of this view of the mechanism of the urinary excretion, it has been ascertained that when the kidneys are interrupted in their function, there is a tendency to the elimination of the excrementitious principles of the urine by lungs, skin, and alimentary canal; and that these matters only accumulate in the blood after this vicarious effort has failed to effect their complete discharge.
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> "These ideas have seemed to be so completely justified by facts, that they have been applied to the mechanism of excretion by other organs, such as the skin and the liver; but within a few years, the older observations with regard to nephrotomized animals have been discredited; and it has been asserted, as the result of experiment, that urea and the urates do not accumulate in the blood after removal of the kidneys, but that this result only follows when both ureters have been tied. The experiments on which this idea is based have been applied mainly to the pathology of uræmic intoxication, but it is evident that they bear directly upon the mechanism of excretion. It is not assumed, however, that excrementitious principles are not formed by the disassimilation of the tissues; but it is asserted that urea and the urates are produced in the kidneys by a transformation of the excrementitious matters, creatine, creatinine, etc., which exist in the blood. It is foreign to our purpose to discuss *in extenso* the pathological conditions produced by the retention of the urinary principles in the blood; and we shall consider this question only so far as it bears upon the physiology of excretion.
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> "The original experiments of Prévost and Dumas are very strong arguments in favour of the view that has been so long almost unquestioned; viz., that urea is simply separated from the blood by the kidneys; but the more recent observations of Bernard and Barreswill, Hammond, and others, while they confirm the first experiments on this subject, have added very considerably to our knowledge of the mechanism of uræmic poisoning after extirpation of the kidneys. The kidneys, it has been found, can readily be removed from living animals, dogs, cats, rabbits, etc., without any great disturbance immediately following the operation. Bernard and Barreswill found that animals from which both kidneys had been removed did not usually present any distinctive symptoms for a day or two after, except that they vomited and passed an unusual quantity of liquid from the intestinal canal. During this period, the blood never contained an abnormal quantity of urea; but the contents of the stomach and intestine were found to be highly ammoniacal. During this time, also, the secretions from the stomach and intestines, particularly the stomach, became continuous, as well as increased in quantity. Animals operated upon in this way usually live for four or five days, and then die in coma following upon convulsions. Toward the end of life, the secretion of gastric and intestinal fluids becomes arrested, probably from the irritating effects of ammoniacal

decomposition of their contents, and then, and then only, urea is found to accumulate enormously in the blood.[1]

"It is thought by Bernard that the hypersecretion by the gastric and intestinal mucous membrane, in nephrotomized animals, is an effort on the part of the system to eliminate the urea, which is decomposed by contact with these membranes into carbonate of ammonia. This view is sustained by the fact that when urea is introduced into the alimentary canal in living animals, it disappears almost immediately and is replaced by the ammoniacal salts.[2] Consequently, after removal of the kidneys, we should not expect to find an increased quantity of urea in the blood, until its elimination by the mucous membrane of the alimentary canal has ceased; but the fact that it then accumulates in large quantity cannot be doubted.

"The results of the experiments of Dr. Hammond entirely correspond with those obtained by Bernard and Barreswill. He has also confirmed the fact, observed by Ségalas and Vauquelin, that urea is an active diuretic when injected in small quantity into the veins of a healthy animal;[3] and that in this case it does not produce any poisonous effects, but is immediately eliminated. But when urea is injected into the vascular system of a nephrotomized animal, it produces death in a very short time, with the characteristic symptoms of uræmic poisoning.[4] We have frequently removed both kidneys from dogs, and when the operation is carefully performed, the animals live from three to five days. In some instances they have been known to live for twelve days or even longer,[5] but death always takes place finally with symptoms of blood-poisoning.

"The experiments which are supposed to show that urea and the urates are actually formed in the kidneys—to which we have already alluded—were made with the view of comparing the effects of removal of both kidneys with those produced by tying the ureters. According to the observations of Oppler, the blood contains much more urea after the ureters are tied than after removal of the kidneys.[6] Perls states, as the result of experiments on rabbits, that no accumulation of urea in the muscular substance can be proved after removal of the kidneys; but that this occurs only after tying the ureters, and the quantity seems to be greatest in the first twenty-four or forty-eight hours after the operation.[7] Essentially the same results were obtained by Zalesky,[8] who asserts that the proportion of urea in the blood after removal of the kidneys in dogs is about the same as in the normal condition. These experiments, which are directly opposed in their results to the well-considered observations of Prévost and Dumas, Bernard and Barreswill, Hammond, and many others, cannot be accepted unless it be certain that all the necessary physiological conditions have been fulfilled. In the first place, it was positively demonstrated, as early as 1847, that urea does not accumulate in the blood immediately after removal of the kidneys, but only toward the end of life, and then it is found in enormous quantity.[1] In the second place, it is well known that the operation of tying the ureters is followed by an immense pressure of urine in the kidneys, which not only disturbs the eliminative action of these organs, but affects most seriously the general functions. Since the influence of the nervous system upon the secretions has been so closely studied, it is evident that the pain and disturbance consequent upon the accumulation of urine above the ligated ureters must have an important reflex action upon the secretions; and this would probably interfere with the vicarious elimination of urea and other excrementitious principles by the stomach and intestines. It is well known to practical physicians that an arrest of these secretions, in cases of organic disease of the kidneys, is liable to be followed immediately by evidences of uræmia, and that grave uræmic symptoms are frequently removed by the administration of remedies that act promptly and powerfully upon the intestinal canal. As additional evidence of the great disturbance of the system, aside from the mere accumulation of excrementitious principles in the blood, which must result from tying the ureters, we have the intense distress and general prostration, always so prominent in cases of nephritic colic, where there is only temporary obstruction of one ureter. The pathological condition of the kidneys which follows the operation of tying the ureters was observed by Richerand, many years ago,[2] and the observations of Oppler, Perls, and Zalesky, on this subject are not entirely novel.[3]

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[1] Bernard, Liquides de l'organisme, Paris, 1859, tome ii. p. 36, et seq. These experiments were first published by Bernard and Barreswill in the Archives générales de médecine, Paris, 1847, tome xiii. p. 449.

[2] Bernard, op. cit., p. 51.

[3] Ségalas, Jl. de Physiologie, Paris, 1822, tome ii.

[4] Hammond, Physiological Memoirs—Uræmic Intoxication, Philadelphia, 1863, p. 347.

[5] Hammond, op. cit., p. 303.

[6] Oppler, Beiträge zur Lehre von der Urämie.—Virchow's Archiv, Berlin, 1861, Bd. xxi., S. 260, et seq.

[7] Perls, in Canstatt's Jahresbericht, Wurzburg, 1865, S. 194. The experiments of Perls are not sufficiently extended to be very satisfactory. Rejecting one experiment in which the animal was killed twenty-four hours after removal of the kidneys—when no accumulation of urea could be expected—there are three examinations of the muscular substance after death from removal of the kidneys, and four after death from tying the ureters. In an examination after removal of the kidneys, 2.32 parts per 1000 of nitrate of urea were found; in the second, there were no crystals in the extract; and in the third there were slight traces of urea. These animals died three or four days after the operation. Five examinations were made of the muscular substance in animals that died after tying the ureters. In three of these examinations, urea was found in considerable quantity; and in the remaining two, urea was present in very small quantity in one instance, and in the other, it is not stated that any urea was found. No examinations were made of the blood. These experiments on the accumulation of urea in nephrotomized animals are hardly sufficient to overthrow the researches of Prévost and Dumas, and others by whom their observations have been confirmed.

[8] Zalesky, Untersuchungen über den uræmischen Process und die Function der Nieren, Tübingen, 1865.

"From a careful review of the important facts bearing upon this question, there does not seem to be any valid ground for a change in our ideas concerning the mode of elimination of urea and the other important excrementitious constituents of the urine. There is every reason to suppose that these principles are produced in the various tissues and organs of the body during the process of disassimilation, are taken up by the blood, and are simply separated from the blood by the kidneys. There may be unimportant modifications of some of these principles in the kidneys or in the urine, such as the conversion of a certain amount of creatine into creatinine, but the great mass of excrementitious matter is separated from the blood by the kidneys unchanged."

In the seventh chapter the properties and composition of the urine are considered. Our author here presents us with an elaborate table representing, very nearly, the latest and most reliable observations upon the relative and absolute quantities of the urinary constituents. The composition of the urine, and the manner in which it is influenced by age, sex, season, periods of the day, food, muscular exercise, and mental exertion, are elaborately discussed.

The physiological anatomy of the liver is minutely described in chapter eighth. Few questions in minute anatomy have attracted more attention than the relations of the hepatic cells to the radicles of the bile-ducts, and the origin of these ducts in the lobuli. Kiernan, in 1833, was led by his researches to suppose that a reticulated network of ducts existed in the lobules, and that these communicated with the ducts in the interlobular spaces. This view was essentially adopted by Prof. Leidy in his paper on the comparative anatomy of the liver published in vol. xv., new series, of this Journal. In his treatise on human anatomy, published thirteen years later, this observer does not offer any positive opinion upon this subject. In 1856 Dr. Beale, of London, maintained that there existed in the lobules delicate tubes, about as wide as the liver-cells, each tube inclosing a row of these cells. Kölliker at one time adopted views somewhat analogous to those of Beale. In the last edition of his work on microscopic anatomy, published at Leipzig in 1867, he abandons these views altogether. According to Prof. Flint, late researches have shown that the following is probably the true relation of the ultimate ramifications of the bile-ducts in the lobules to the hepatic cells :—

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[1] Bernard and Barreswill, loc. cit.

[2] Richerand et Bérard, Nouveaux élémens de physiologie, Paris, 1833, tome ii. p. 142.

Richerand noted great disturbance in animals, thirty-six hours after tying both ureters. In a cat on which this operation had been performed, death took place on the third day. "The kidneys were swollen, softened, and, as it were, macerated; all the organs, all the humours, and all the blood itself, participated in this urinous diathesis." (*Loc. cit.*, p. 143.)

[3] Milne-Edwards, Leçons sur la Physiologie, Paris, 1862, tome vii. pp. 457, 459.

"In the substance of the lobules is an exceedingly fine and regular network of vessels, of uniform size, about $\frac{1}{10000}$ of an inch in diameter,[1] which surround the liver-cells, each cell lying in a space bounded by inosculating branches of these canals. This plexus is entirely independent of the bloodvessels, and it seems to inclose in its meshes each individual cell, extending from the periphery of the lobule, where it is in communication with the interlobular bile-ducts, to the intralobular vein in the centre. The vessels probably have excessively thin, homogeneous walls—though the existence of their membrane has not been positively demonstrated—and are without any epithelial lining, being much smaller, indeed, than any epithelial cells with which we are acquainted. This arrangement, as far as is known, has no analogue in any other secreting organ.

"Although it is within three or four years only that the reticulated bile-ducts of the lobules have attracted much attention, they were discovered in the substance of the lobules, near the periphery, by Gerlach, in 1848.[2] It is evident, from an examination of his figures and description, that he succeeded in filling with injection that portion of the lobular network near the borders of the lobules, and demonstrated the continuity of their vessels with the interlobular ducts; but he did not recognize the vessels nearer the centre of the lobule. His views, however, received very little attention, and are not even mentioned in most of the authoritative works on general anatomy. Within the last few years, Budge,[3] Andrejevic,[4] Mac-Gillavry,[5] Chrzonszczewsky,[6] Wyss,[7] Hering,[8]

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[1] This is the result of the measurements by Dr. Stiles (Bulletin of the New York Academy of Medicine, 1868, vol. iii. p. 351), of the ducts in the livers of the bullocks that died of the "Texas disease," which we have verified in the same specimen. The measurements given by Frey are about the same (Handbuch der Histologie, Leipzig, 1867, S. 558).

[2] Gerlach, Handbuch der allgemeinen und speciellen Gewebelehre, Mainz, 1848, S. 280, et seq.

[3] Budge, Ueber den Verlauf der Gallengänge.—Archiv für Anatomie, Physiologie und wissenschaftlichen Medicin, Leipzig, 1859, S. 642, et seq.

[4] Andrejevic, Ueber den feineren Bau der Leber.—Sitzungsberichte der mathematisch-naturwissenschaftlichen Classe der Kaiserlichen Akademie der Wissenschaften, Wein, 1861, Bd. xliii., I. Abtheilung, S. 379, et seq.

[5] Mac-Gillavry, Zur Anatomie der Leber, Idem, Wein, 1865, Bd. i., II. Abtheilung, S. 207, et seq.

[6] Chrzonszczewsky, Zur Anatomie und Physiologie der Leber.—Virchow's Archiv, Berlin, Jan., 1866, Bd. xxxv., S. 153, et seq.

[7] Wyss, Beitrag, zur Histologie der icterischen Leber.—Virchow's Archiv, Berlin, April, 1866, Bd. xxxv., S. 553, et seq.

[8] Hering, Ueber den Bau der Wirbelthierleber.—Sitzungberichte, etc., Wein, 1866, Bd. liv., I. Abtheilung, S. 335.

> Frey,[1] Eberth,[2] Kölliker,[3] and others, have investigated this interesting question, by various methods, and have arrived at the most positive and satisfactory results. It is now demonstrated, beyond a doubt, that there are either canals or interspaces between the liver-cells in the lobules, and that these open into the interlobular hepatic ducts. It is still a question of discussion, whether these passages are simple spaces between the cells, or are lined by a membrane; but this point has no great physiological importance, and we can readily imagine that it would be exceedingly difficult to demonstrate a membrane forming the wall of a tube, the whole measuring but $\frac{1}{10000}$ of an inch. In the investigations which have thus demonstrated the arrangement of the finest bile-ducts in the lobules, the livers of rabbits have been found to present the most favourable conditions. It has been assumed, however, that in the method of study by artificial injection, the appearance of canals might be due to the extravasation of the fluid, which might possibly take on a regular arrangement between the cells. This is an error of observation that would not be unlikely to occur; but not only have these fine ducts been filled by injection, and their connection with the interlobular ducts apparently established, they have been observed filled with inspissated bile in icteric livers.[4] A method of study, very ingenious and highly satisfactory in its results, was adopted by Chrzonszczewsky. He introduced into the bloodvessels or stomach of a living animal a solution of indigo-carmine, and within one or two hours, killed the animal, when the whole network of ducts in the lobules was found unbroken and connected with the interlobular vessels. The drawings of these appearances accompanying the memoir are exceedingly beautiful.[5]
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> "A peculiarly favourable opportunity for observing the bile-ducts in the lobules was presented in the livers of animals that died of the so-called 'Texas cattle-disease.' This was taken advantage of by Dr. R. C. Stiles, who was able to verify, in the most satisfactory manner, the facts which have lately been established by the German anatomists.[6] In these livers, the finest bile-ducts were found filled with bright yellow bile, and their relations to the liver-cells were beautifully distinct. In the examination of these specimens, the presence of what appeared to be detached fragments of these little canals is an argument in favour of the view that they were lined by a membrane of excessive tenuity. These interesting anatomical points were demonstrated by Dr. Stiles before the New York Academy of Medicine, and we have since been able to verify them in every particular."

With regard to the secretion of bile, Prof. Flint maintains that certain elements of this fluid are separated from the blood, while others are manufactured from materials supplied by the blood in the liver-cells situated outside of the plexus of origin of the biliary duct, and subsequently taken up by these delicate vessels and carried to the excretory biliary passages. He believes also that bile is produced in the liver from the blood distributed in its substance by the portal vein and the hepatic artery, and not from either of these vessels exclusively; and that the bile may continue to be secreted, if either one of these vessels be obliterated, provided the supply of blood be sufficient.

The subject matter of the next chapter is the excretory function of the liver. Our author here treats of the general properties and composition of the bile, the origin of the biliary salts and their tests, &c. The greater part of this chapter, however, is taken up with a condensed account of Prof. Flint's researches into the origin of cholesterine, its absorption by the blood circulating through the brain, its elimination by the liver, and its accumulation in the blood in certain cases of organic, hepatic disease. With these researches our readers are familiar, as the paper in which they were originally detailed was published in this Journal in 1862.

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[1] Frey, Handbuch der Histologie, Leipzig, 1867, S. 557, et seq.

[2] Eberth, Untersuchungen über die normale und pathologische Leber.—Virchow's Archiv, Berlin, Mai, 1867, Bd. xxxix., S. 70, et seq.

[3] Kölliker, Handbuch der Gewebelehre, Leipzig, 1867, S. 428.

[4] Wyss, loc. cit.

[5] Loc. cit.

[6] Stiles, Bulletin of the New York Academy of Medicine, 1868, vol. iii. p. 350; Report of the New York State Cattle Commissioners, in connection with the Special Report of the Metropolitan Board of Health on the Texas Cattle-Disease.—Transactions of the New York State Agricultural Society, Albany, 1868, vol. xxvii.—1867, Part ii., pp. 1137, 1160; and Third Annual Report of the Metropolitan Board of Health of the State of New York, Albany, 1868, p. 303.

That much vexed question, the glycogenic function of the liver, is ably discussed in chapter tenth. It is well known that in 1848, Claude Bernard, as the result of a series of elaborate experiments, announced that the liver is constantly producing sugar of the variety that had long been recognized in the urine of persons suffering from diabetes mellitus. Nine years later this observer discovered in the substance of the liver a peculiar sugar, forming material analogous in its composition and properties to starch. He demonstrated that in all animals the blood coming from the liver by the hepatic veins contains sugar; and that the presence of this principle here is not dependent upon the starch or sugar of the food. He also showed that in carnivorous animals, fed exclusively upon meat, no sugar could be found in the blood of the portal vein; but, under normal conditions, it is always present in the blood of the hepatic veins. He furthermore proved that the amount of sugar is proportionately diminished in passing from the liver to the heart, and that it finally disappeared while passing through the lungs.

The experiments of Bernard and the conclusions based upon them, have given rise to a very animated controversy among physiologists. Lehmann, Frerichs, Poggiale, Leconte, and others have confirmed them; while Figuier, Pavy, McDonnell, Meissner, Jaeger, Schiff, and others have failed to verify them. In Great Britain the conviction prevails that the liver does not produce sugar during life, and that the sugar found by Bernard and others is due to *post-mortem* action. With the view of harmonizing, if possible, the discordant observations of Bernard and Pavy, Prof. Flint instituted a number of experiments which he details at length:—

> "From our own experiments we have come to the conclusion that Dr. Pavy and those who adopt his views cannot consistently deny that sugar is constantly formed in the liver and discharged into the blood of the hepatic veins; nor can Bernard and his followers ignore the fact that the liver does not contain sugar during life; although, as has been shown by Pavy, and more specifically by McDonnell,[1] sugar appears in the liver in great abundance soon after death.
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> "In the experiments that we have just detailed, which are simply typical examples of numerous unrecorded observations, we attempted to verify the observations of Pavy without losing sight of the facts observed by Bernard, and to verify the experiments of Bernard in the face of the apparently contradictory statements of Pavy. When an animal is in perfect health, has been kept quiet before the experiment, and a piece of the liver is taken from him by two sweeps of the knife, the blood rinsed from it and the tissue cut up into water already boiling, the whole operation occupying only ten seconds (as was the case in Experiment III.), the liver is as nearly as possible in the condition in which it exists in the living organism. As this was done repeatedly in animals during digestion and in the intervals of digestion, and an extract thoroughly made without finding any sugar, we regarded the experiments of Pavy as entirely confirmed, and the fact demonstrated that the liver does not contain sugar during life. On the other hand, when we made the experiment on the

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[1] Observations on the Functions of the Liver, Dublin, 1865.

liver as above described, and, in addition, took specimens of the portal blood and the blood from the hepatic veins, under strictly physiological conditions (as was done in Experiment IV.), and found no sugar in the portal blood or in the substance of the liver, but an abundance in the blood of the hepatic veins, it was impossible to avoid the conclusion that the sugar was formed in the liver, and was washed out in the blood as it passed through.

"In treating of the mechanism of the formation of sugar in the liver, we will describe more fully the glycogenic matter; but, taking into consideration the demonstration of the presence of sugar in the blood of the hepatic veins by Bernard; his discovery of the *post-mortem* production of sugar in a liver washed sugar-free, probably from a substance remaining in the liver and capable of being transformed into sugar; the negative results of the examinations of the liver for sugar by Pavy; and, adding to this our own experiments upon all of these points, we are justified in adopting the following conclusions:—

"1. A substance exists in the healthy liver, which is capable of being converted into sugar; and inasmuch as this is formed into sugar during life, the sugar being washed away by the blood passing through the liver, it is perfectly proper to call it glycogenic, or sugar-forming matter.

"2. The liver has a glycogenic function, which consists in the constant formation of sugar out of the glycogenic matter, this being carried away by the blood of the hepatic veins, which always contains sugar in a certain proportion. This production of sugar takes place in the carnivora, as well as in those animals that take sugar and starch as food; and it is, essentially, independent of the kind of food taken.

"3. During life, the liver contains only the glycogenic matter and no sugar, because the great mass of blood which is constantly passing through this organ washes out the sugar as fast as it is formed; but after death, or when the circulation is interfered with, the transformation of glycogenic matter into sugar goes on; the sugar is not removed under these conditions, and can then be detected in the substance of the liver."

The ductless glands receive attention in the next chapter. Our author here describes the minute anatomy of the spleen, suprarenal capsules, thyroid, thymus, and perineal glands, and the pituitary body. Notwithstanding the labour bestowed upon the study of these organs, their function still remains a *terra incognita* in physiology.

In the next three chapters our author treats of nutrition, the nature of the forces involved in it, and the conditions which influence it; animal heat and its sources, the circumstances which produce fluctuation in the temperature of the body, the relations of animal heat to the various processes of nutrition, the influence exerted upon it by the nervous system, and the manner in which it is equalized. In this part of his work Prof. Flint endeavours to determine in what part or parts of the organism heat is generated; what is the relative importance of the several processes of nutrition in regard to the amount of heat generated; what are the principles invariably and of necessity consumed and produced in the organism in calorification; what is the relative importance of the principles thus consumed, and the products thus generated and thrown off; and lastly how far we have been able to follow the material transformations in the organism which involve the consumption of certain principles, the production of new compounds, and the generation of heat.

Not the least important part of the volume before us is comprised in the last three chapters, in which the general properties of contractile tissues, muscular contraction, the passive organs of locomotion, and the physiology of the voice and speech are taken up in detail and examined at length.

With this brief notice of its contents, we take leave of the third part of Prof. Flint's admirable treatise, cordially recommending it to the careful examination of those interested in physiological studies. J. A. M.